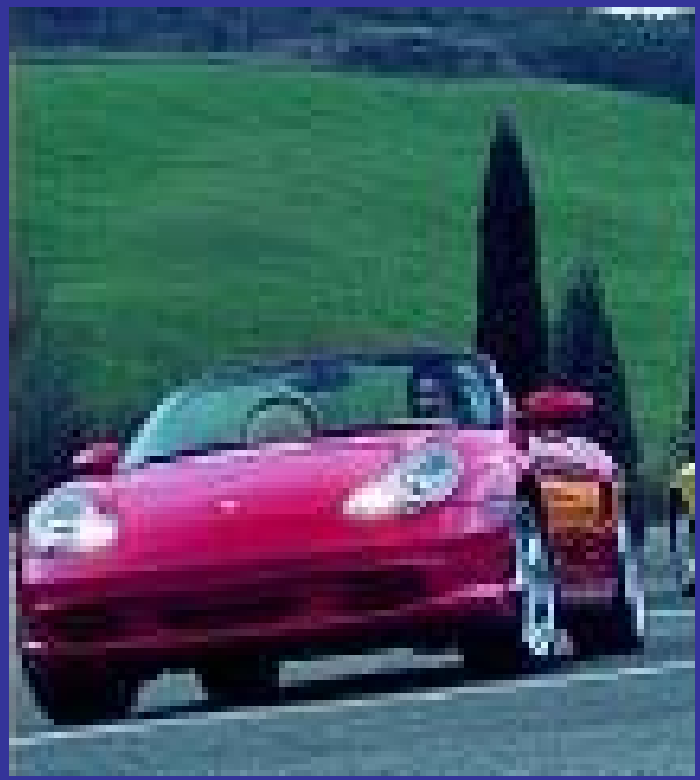
CHAPTER 5

RANDOM MATING POPULATIONS:

HARDY-WEINBERG PRINCIPLE

In a sexual population, each genotype is unique, never to recur. The life expectancy of a genotype is a single generation. In contrast, the population of genes endures.

James F. Crow (2001)



Models in biology

Models are used to simulate the real world.

Models range from Mendelian genetics to complex global climate models that have led to concerns about climate change to general relatively.

Models are important for understanding how nature works. They are used to make predictions that allow testing of hypotheses and theories.

Observation > theories > models > predictions > observations

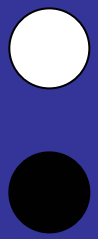
The Hardy-Weinberg Principle is the fundamental model of population genetics.

Today, the Hardy-Weinberg Law stands as a kind of Newton's First Law (bodies remain in their state of rest or uniform motion in a straight line, except insofar as acted upon by external forces) for evolution: Gene frequencies in a population do not alter from generation to generation in the absence of migration, selection, statistical fluctuation, mutation, etc.

Robert M. May (2004)

Assumptions of Hardy-Weinberg model

1. Random mating.
2. No mutation.
3. Large (infinite) population size.
4. No differential survival or reproduction
   (i.e., no natural selection).
5. No immigration



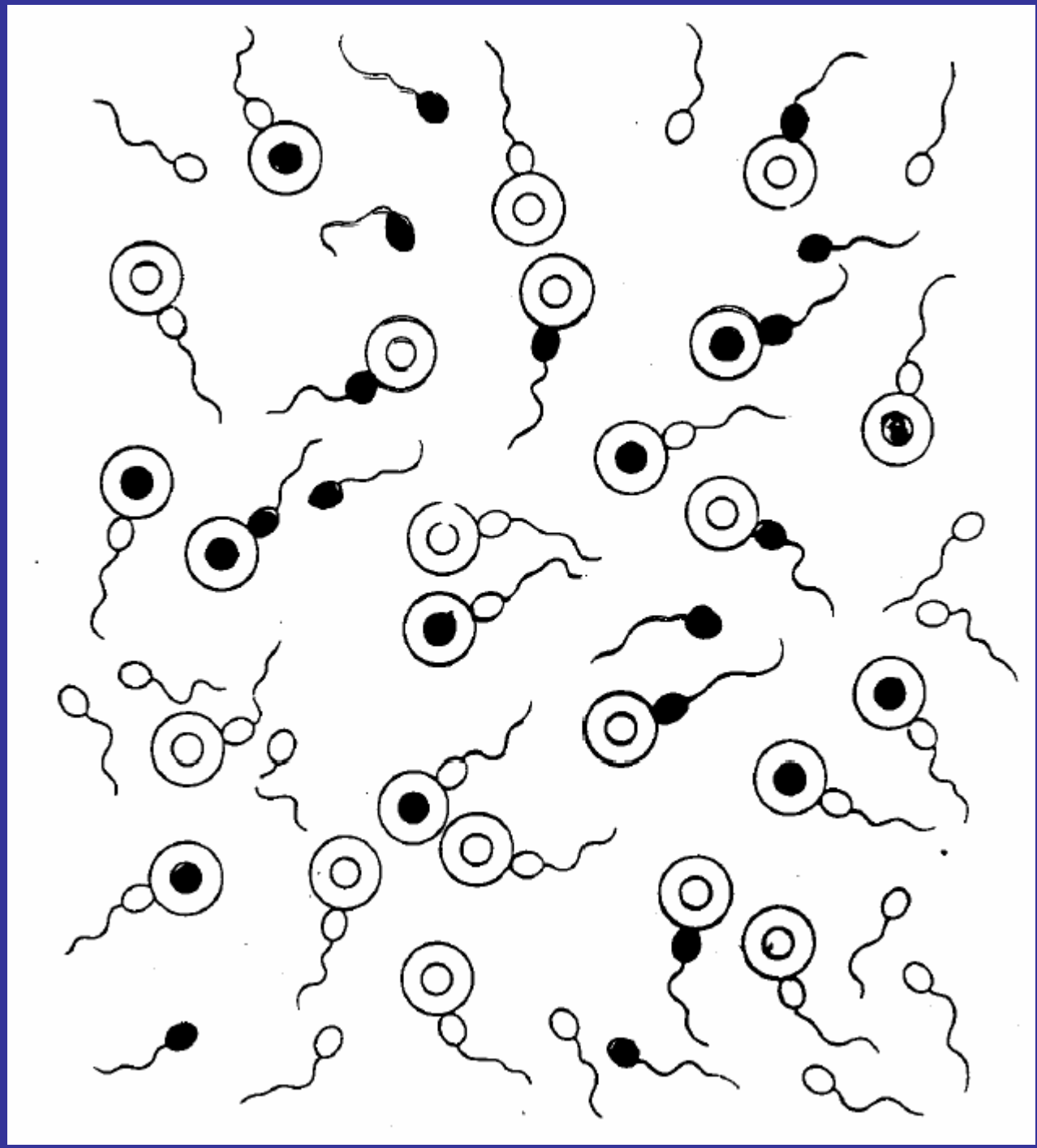
A

a

p = freq(A)
= 0.6

q = freq(a)
= 0.4

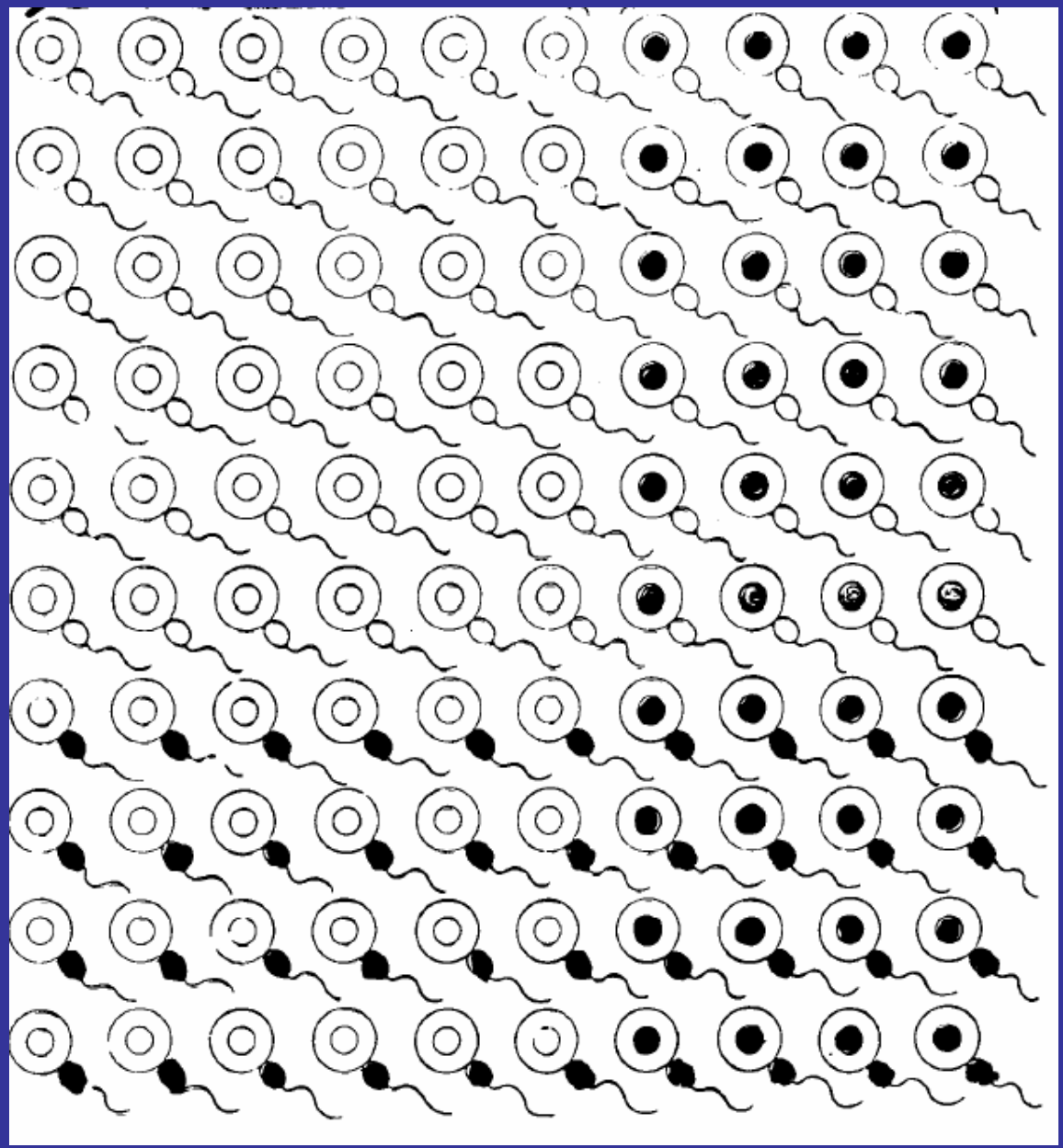
$p = 1 - q$



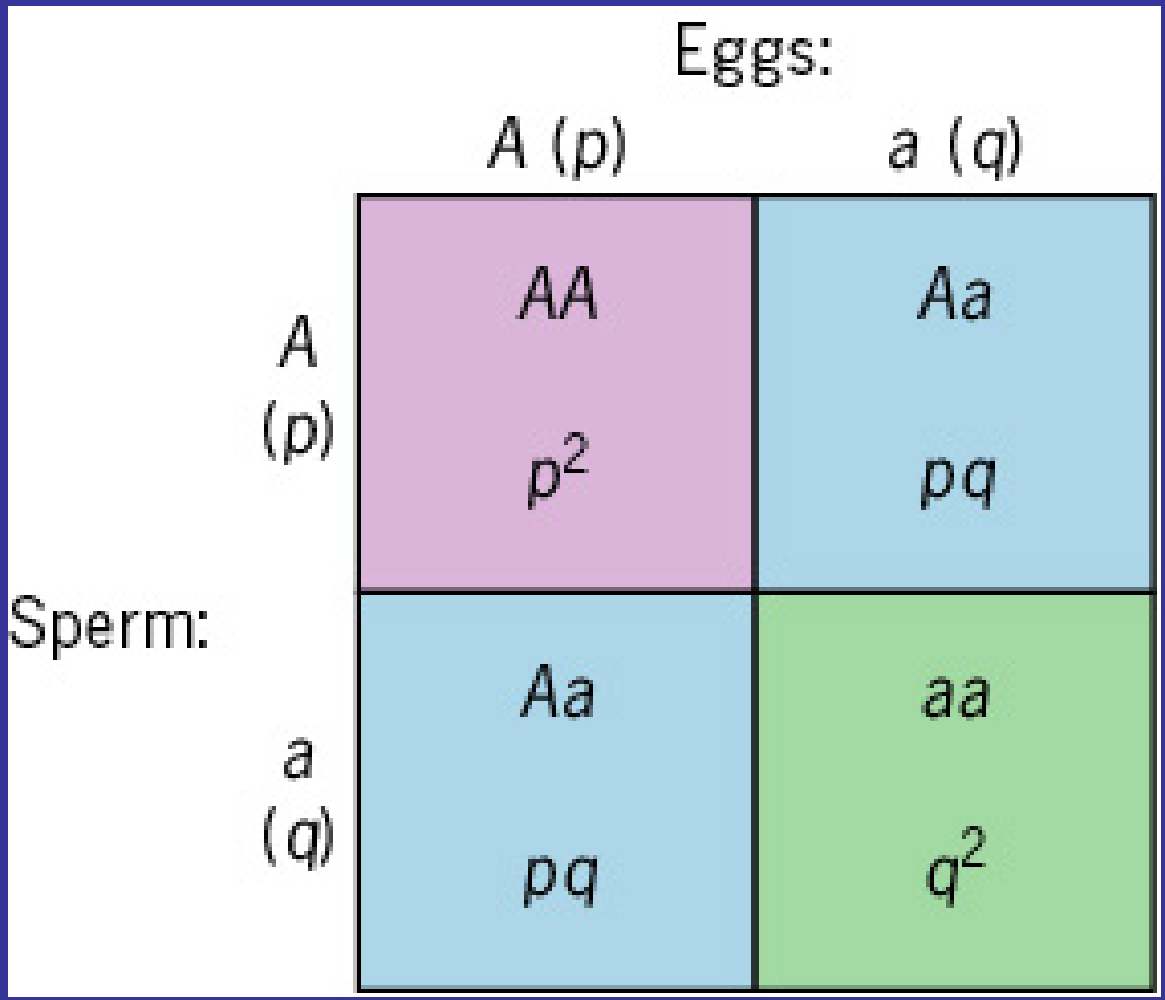
$p = 0.6$ $q = 0.4$

$p = 0.6$

$q = 0.4$



General result



$$p^2 + 2pq + q^2$$

More than two alleles:

In the case of three alleles the following genotypic frequencies are expected:

$p = \text{freq}(A_1)$
$q = \text{freq}(A_2)$
$r = \text{freq}(A_3)$

$$(p+q+r)^2 = p^2 + 2pq + q^2 + 2pr + 2qr + r^2$$

$$A_1A_1 \quad A_1A_2 \quad A_2A_2 \quad A_1A_3 \quad A_2A_3 \quad A_3A_3$$

If the Hardy-Weinberg assumptions are met, then the following will be true:

1. The population will not evolve; that is, allele (and genotype) frequencies will be constant from generation to generation.

   Hardy-Weinberg equilibrium

2. Genotypes will be in binomial proportions.

   Hardy-Weinberg proportions

Utility of the Hardy-Weinberg Model

Essential for understanding genetic variation in natural populations:

- Conservation
- Evolution
- Medicine
- Forensics
- Genetic counseling